OSTRF
Oil Sands Tailings Research Facility

OSTRF News

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March 2010

UNIVERSITY OF ALBERTA

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OSTRF researchers create hand-held NAs fluorescence scanner

With a $50,000 grant from the Canadian School of Energy and Environment (CSEE), researchers from the OSTRF and electrical engineering at the University of Alberta collaborated on building a miniature fluorescence sensor to detect and characterize naphthenic acids in process-affected waters.

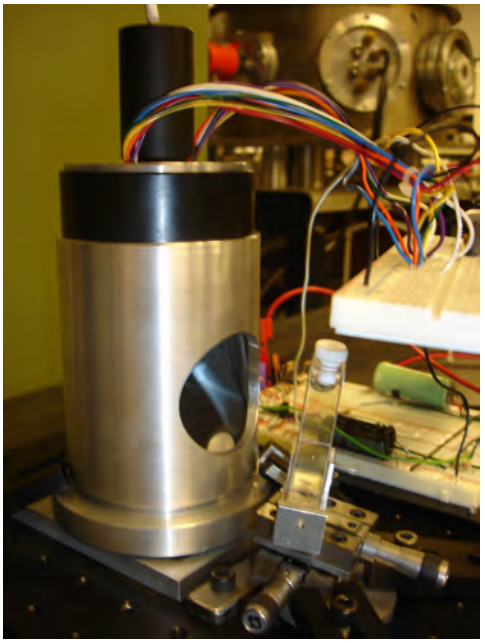
Naphthenic acids (NAs) are natural components found in the bitumen from oil sands. Under present oil sands production methods, NAs are released from the bitumen into process-affected waters at concentrations ranging from 40 to 120 mg/L.

Toxic to various organisms, NAs also cause corrosion issues within refinery units in the extraction process. The researchers developed the sensor to monitor the presence, migration and biodegradation of NAs in process-affected waters to mitigate their environmental and operational impacts.

The sensor employs a multi-wavelength light source consisting of several emitting diodes (LEDs) and an advanced detection system to collect fluorescence excitation-emission matrices (EEMs) that present all the fluorescence spectral features of detected compounds in one plot.

For example, petroleum NAs show characteristic fluorescence signatures when excited by ultraviolet light in the range of 260-350 nm. The generated fluorescence signal is unique and could be used to characterize these compounds. Furthermore, changes in the fluorescence signature or fingerprint of NAs reveal chemical changes, degradation or aging of the compound.

The fluorescence scans generated by the developed miniature sensor show good spectral matching to data generated by a standard laboratory fluorescence spectrometer. This technology offers a cost effective, compact, non-invasive and continuous water quality monitoring tool that can detect, characterize and track changes of NAs in process-affected waters.



OSTRF NAs fluorescence sensor with sample cuvette

Compact and portable OSTRF NAs fluorescence sensor

TAILINGS AND MINE WASTE CONFERENCE COMES TO CANADA FOR THE FIRST TIME

Between November 1 and 4, 2009, the OSTRF and University of Alberta Geotechnical Centre hosted over 260 mine waste managers, engineers, regulators and researchers at Tailings and Mine Waste '09. The conference was held at the Banff Springs Hotel in Banff, Alberta.

Beginning in 1994 at Colorado State University, this was the first time the annual conference was held in Canada. Participants from Western Canada, the USA and abroad presented new ideas and discussed the latest developments in issues related to tailings and mine waste management.

This year, three keynote presentations were made by Dr. Ward Wilson, Drs. J. Sobkowicz and N. Morgenstern, and Dr. Gord McKenna. A special session on Oil Sands Tailings and Mine Wastes was also included. The conference proceedings are composed of 80 technical papers, and presentations are available for download (see www.ostrf.com/seminars).

The OSTRF would like to thank the industry sponsors that helped make the conference a success. The next Tailings and Mine Waste conference will be held in Colorado later this year.

Participants enjoying the conference ice breaker

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COACH'S CORNER by Dave Sego, Principal Investigator, Oil Sands Tailings Research Facility

In a short span of only six years, the OSTRF has established itself as a unique academic and industrial research facility producing leading technologies for oil sands tailings management.

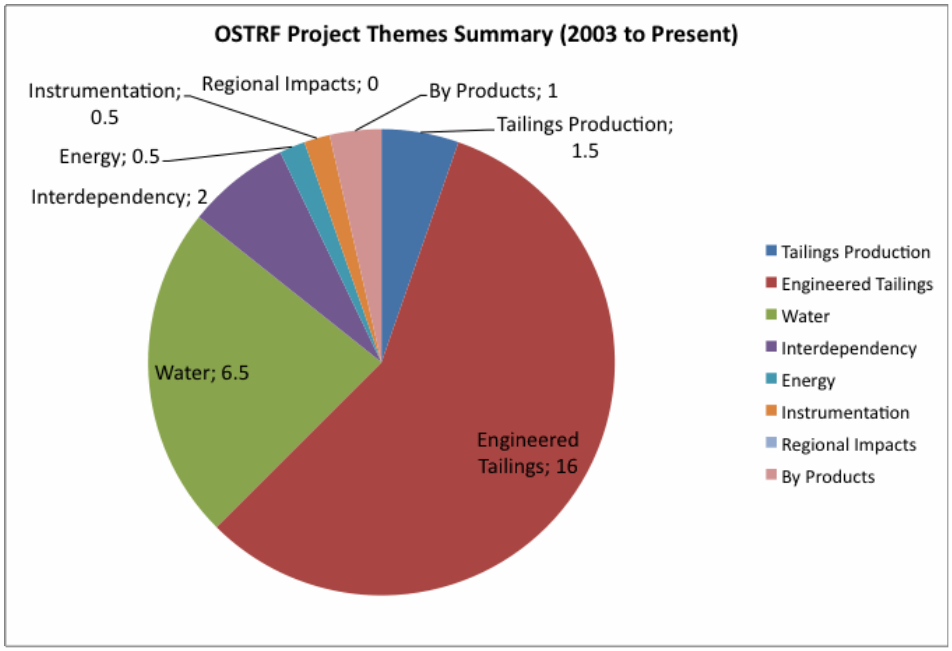
With recent developments, such as the ERCB's Directive 74, and the vast amount of disturbed land and quantity of oil sands tailings being stored, the need to enhance tailings management is now more important than when OSTRF was established in 2003. The Facility provides crucial infrastructure for research opportunities at the intermediate scale not presently available for university research in Canada, compared to existing bench and full-scale research efforts. Since its induction, the OSTRF has reported up to 28 separate projects in collaborative and multidisciplinary oil sands tailings research.

However, it's no secret that people are the most important resource in the oil sands industry. The OSTRF is fulfilling its mandate to educate highly qualified people with special knowledge about oil sands tailings to work in Alberta. To date, 15 students have graduated and either are working directly for operating companies or for regulatory agencies and consulting firms providing professional services to the industry (see "Where are they now?" on page 3) or continued in PhD-level studies in oil sands at the University of Alberta.

The OSTRF has been especially successful in attracting young Canadians with exceptional academic qualification to carry out its research projects. Of the 13 ongoing projects, three of the students hold a national scholarship. Of the 15 completed projects, three of the students held NSERC or industrial scholarships. This demonstrates the high quality of the graduate students being drawn to work on oil sands tailings issues.

All students participate in OSTRF-organized Student-Industry Interaction Days (held annually), ensuring the technology transfer of research ideas and developed concepts. Technology Demonstration Days and various conferences, including the First International Oil Sands Tailing Conference and more recently the 13th International Tailings and Mine Waste Conference (see cover page), also provide a significant opportunity for industry to interact with student researchers and to exchange ideas about research being carried out within the OSTRF in relation to industry needs.

Currently, the greatest research emphasis is on engineered tailings and the managing and treating of water. The focus of the Facility's previously and presently funded research projects and their relation to these themes is presented below. The OSTRF's active projects fund 13 students (seven PhD and six MSc) and one Postdoctoral Fellow. The funding support from each sponsoring company is greatly appreciated by the students and research supervisors.



Additional outside funding to OSTRF projects has allowed the overall research program to expand and thus meet the Facility's research mandates. Through contributions and grants from the Alberta Energy and Research Institute (now Alberta Innovates - Energy and Environment Solutions), NSERC and the Canadian School for Energy and the Environment (CSEE), the OSTRF has received over $450,000 in support in the past four years. This generous support will help the OSTRF attract more world-class researchers and produce even more innovative technologies.

As we step into a new decade, the OSTRF will continue to lead the world in oil sands and tailings research, develop novel approaches for tailings management and educate and train the future leaders of the oil sands industry.

WHAT'S UP

The OSTRF, University of Alberta and Canadian Oil Sands Network for Research and Development (CONRAD) will host the 2nd International Oil Sands Tailings Conference December 5-8, 2010, in Edmonton, Alberta. Details are available at www.ostrf.com/seminars. If you are interested in exhibitor booths or providing sponsorship, please contact Sally Petaske at sally.petaske@ualberta.ca.

The Australian Centre for Geomechanics (ACG) is hosting the 1st International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste in Perth, Western Australia, from September 29 to October 1, 2010. More info available at www.minewaste2010.com.

The 14th International Tailings and Mine Waste Conference will be held in Vail, Colorado, on October 17-20, 2010.

The next installment of the OSTRF Student-Industry Interaction Day will be held September 23, 2010, at the Alberta Research Council Millwoods Facility. Additional information will be posted soon at www.ostrf.com.

Additional Info

Readers are referred to the OSTRF website (www.ostrf.com) for the latest information regarding the OSTRF, including current and previous OSTRF project summaries, publications and upcoming events.

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WHERE ARE THEY NOW?

The OSTRF's mandate includes the training of highly qualified scientists and engineers who will become the next generation of oil sands industry leaders, consultants and regulators. Here is what our former OSTRF students are up to:

- Bryan Bales, MSc Geotechnical Eng. (2007) – AMEC, Calgary
- Nicholas Beier, MSc Geoenvironmental Eng. (2006) – PhD studies, UofA, OSTRF
- Michelle Chang, MSc Chemical Eng. (2010) – Sunor Energy, Fort McMurray
- Chengmai Guo, PhD Geotechnical Eng. (2009) – Suncor Energy, Fort McMurray
- Neil Hall, MSc Water Resources Eng. (2009) – AECOM, Edmonton
- Nafisul Islam, MEng Geoenvironmental Eng. (2008) – Sabbatina Geotechnical, Edmonton
- Silawat Jeevaripoolvam, MSc Geotechnical Eng. (2005) – PhD studies, UofA
- Heather Kaminsky, PhD Chemical Eng. (2008) – Total E&P, Calgary
- Carmen Li, MSc Biological Sciences (2010) – Bio. Science Laboratory, UofA
- Yetimega Mihiretu, PhD Geotechnical Eng. (2009) – ERCB, Fort McMurray
- Eric Niven, MSc Geotechnical Eng. (2006) – PhD studies, UofA
- Amena Sadek, MEng Environmental Eng. (2008) – Returned to Egypt
- Renata Wood, MSc Geotechnical Eng. (2003) – AMEC, Vancouver
- Shihong Wu, MSc Geotechnical Eng. and Renewable Resources (2009) – Klohn Crippen Berger, Vancouver
- Juwen Yang, PhD Geotechnical Eng. (2009) – Dam Safety, Edmonton

STUDENT FOCUS - CHENXI ZHANG (MSc Geotechnical Eng.)

Oil sands total tailings are transported from the plant to the tailings pond through a pipeline as a stream of slurry. This slurry contains water, coarse particles (sand), fine particles (clay and silt) and traces of residual bitumen. After being discharged from the pipeline into the disposal area, the coarse particles settle quickly and form a beach, leaving a fine particle content of 6-10% in the fluid. After a few years of settling, the remaining fines achieve 30-35% solid content in the pond and are called mature fine tailings (MFT). Due to its very slow consolidation rate, MFT needs decades to settle and will remain in tailings ponds for a long time which is an environmental concern.

A potential solution to prevent the formation of MFT is to physically increase the oil sands total tailings stream's solid content to over 70% before depositing it into the tailings pond. My research focuses on cross flow filtration technology as a potential dewatering method. Using real oil sand total tailings, I test different parameters (such as the effect of filter pipe media, tailings composition, tailings solid content and residual bitumen) to see how they affect the performance of the cross flow filtration on the tailings.

So far, we found that filter pipes with higher porosity generate higher filtrate flux rates, and coarser tailings also have higher filtrate flux rates. Moreover, the filtrate flux rate can be constantly maintained even with increasing slurry solid content (55%-70%). However, the presence of residual bitumen forms a froth layer inside the filter pipe and reduces filtrate flux rate. All investigations suggest that high-quality filtrate water can be generated from these processes. The heated water released from the total tailings is also recycled and has the potential to reduce greenhouse gas emmisions. I am continuing research experiments on the effect of slurry velocity and transmembrane pressure to better understand their effects on cross flow filtration.

The accumulation of MFT in tailings ponds is an environmental concern and can cause long-term environmental liabilities. As such, it is important to continue investigating methods to prevent the formation of MFT in tailings ponds.

Chenxi Zhang shows the filtrate water (right hand) separated from feed tailings (left hand)

Graduate students team up to treat oil sands process-affected water

L to R: Parastoo Pourrezaei, Yingnan Wang and Nan Wang compare the OSPW before and after pre-treatment

Water is an essential resource for oil sands operation. Oil sands process-affected water (OSPW) produced from operation processes is composed of suspended and dissolved solids, hydrocarbons, salts, metals and organic acids such as naphthenic acids (NAs).

Dr. Mohamed Gamal El-Din's group in Environmental Engineering is finding the best solutions for the remediation of OSPW. Yingnan Wang (MSc) is studying pre-treatment processes to remove suspended solids, metals and partial NAs from OSPW. Parastoo Pourrezaei (PhD) is working on the adsorption of organic compounds in OSPW by means of petroleum coke as one of the by-products generated from bitumen extraction in the oil sands industry. Nan Wang (MSc) is trying to decrease the toxicity of OSPW with advanced oxidation and biological processes.

The objective of the project is to evaluate the applicability of conventional and advanced water treatment technologies and to set up an effective and economical combination of treatment processes for the reuse and safe discharge of OSPW.

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CURRENT STUDENT PROJECTS

1. Water Treatment Options and Their Applicability to Oil Sands Operations for Recycle and Safe Discharge – Yingnan Wang (MSc Environmental Engineering, 2010)
2. Crossflow Filtration for Dewatering Oil Sands Total Tailings – Chenxi Zhang (MSc Geotechnical Engineering, 2010)
3. Foam Tailings: A New Methodology of Stabilization of Tailings – Ehsan Abazarit (PhD Geotechnical Engineering, 2010)
4. Dewatering Behaviour of Oil Sands Tailings from Different Processes – Saidul Alam (PhD Geoenvironmental Engineering, 2010)
5. Implications of Tailings Management and Planning Options – Nicholas Beier (PhD Geoenvironmental Engineering, 2010)
6. Dewatering Non-Segregating Mixtures of Oil Sands Taiings – Reza Moussavi Nik (PhD Geotechnical Engineering, 2010)
7. Fluorescence Characterization of Naphthenic Acids – Michael Alostaz (Postdoctoral Fellow Geoenvironmental Engineering, 2010)
8. Characterization of Petroleum Naphthenic Acids in Oil Sands Process-Affected Waters Using Fluorescence Technology – Andrea Ewanchuk (MSc Geoenvironmental Engineering, 2011)
9. The Removal of Naphthenic Acids in Oil Sands Process-Affected Water by Coke Adsorption – Christina Small (MSc Geoenvironmental Engineering, 2011)
10. Freeze-Thaw Dewatering of Albian Mature Fine Tailings – Ying Zhang (MSc Geotechnical Engineering, 2011)
11. Sand and Slurry Jets in Artificial and Real MFT Without Water-Capping – Jianan Cai (PhD Water Resources Engineering, 2011)
12. Consolidation Behaviour of MFT Using Centrifuge – Amarebh Sorta (PhD Geotechnical Engineering, 2011)
13. Advanced Treatment of Oil Sand Tailings Water – Parastoo Pourrezaei (PhD Environmental Engineering, 2012)

CONGRATULATIONS

The OSTRF extends congratulations to the following individuals for successfully defending their thesis research projects:

Chengmai Guo, PhD Geotechnical Engineering

Carmen Li, MSc Biological Sciences

Yetimega Mihiretu, PhD Geotechnical Engineering

Shihong Wu, MSc Geotechnical Engineering

Juwen Yang, PhD Geotechnical Engineering

OSTRF MANDATE

To develop novel approaches for tailings treatment, to reduce their volume and to improve their physical characteristics to assist in the development of cost-effective, environmentally superior post depositional restoration.

To attract world-class researchers and students to undertake projects at the facility.

To train significant pools of highly qualified scientists and engineers who will become the next generation of oil sands industry leaders, consultants and regulators.

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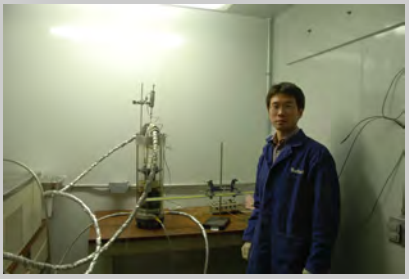
NEW STUDENT PROJECTS: FREEZE-THAWING OF MATURE FINE TAILINGS

Freeze-thaw dewatering is a promising way to initiate reclamation in tailings ponds. Although this dewatering method has been investigated by various research institutes, different mine sites and extraction processes result in different properties and behaviours of the resulting mature fine tailings (MFT).

Ying Zhang, an MSc student in Geotechnical Engineering, is investigating the effects of freezing and thawing on the permeability and post-thaw consolidation behaviour of Albian Sands Energy Inc.'s MFT for the OSTRF.

His research, which began May 2009, consists of two series of freeze-thaw tests: small scale single-layer tests and multi-layer tests. These tests focus on the mechanisms of pore water release and undrained shear strength increase of the MFT. From these experiments, Zhang can modify previous theories and predict the behaviour of Albian MFT after freeze-thaw more precisely.



Ying Zhang tackles mature fine tailings through freeze-thaw dewatering methods